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The invention concerns a procedure for the production of a pressure product by very low-temperature dismantling of air in a rectification system, which exhibits a Drucksäule and a low pressure column, whereby this procedure covers in the patent claim 1 specified step A to e.

The rectification system of the invention can be designed as two-column system, for example as classical double column system, in addition, as three or multi-column system. It can additionally to the columns to nitrogen oxygen separation further devices for the production of other air components, in particular from noble gases (for example krypton, xenon and/or argon) exhibit.

The oxygen-rich parliamentary group, which is used as employment for the mixing column, exhibits a Sauerstoffkonzentration, which is higher than that from air and for example about 70 to 99.5 mol%, preferably with 90 to 98 mol% is. By mixing column a counter current contact column is understood, in which a easy-light gaseous parliamentary group of a heavy-volatile liquid is against-sent.

The procedure according to invention is suitable in particular for the production of gaseous impure oxygen under pressure. As impure oxygen a mixture with an oxygen content is understood less, in particular here about 99,5 mol% or from 70 to 99.5 mol%. The product pressures are for example with 4 to 16 bar, preferably with 5 to 12 bar. Of course the pressure product can be further consolidated if necessary in gaseous condition.

A procedure of the kind initially specified is well-known from the EP 531182 A1. Here liquid oxygen is pumped and given up on a mixing column, into whose sump a component current of air is injected as heat distribution medium stream. The gaseous head product of the mixing column is warmed up against air and exhausted as pressure product. Thus the product under the pressure of the mixing column can be won. Mixing column air must be brought before the feed on a pressure, which is at least the same as the mixing column pressure.

The invention is the basis the task to indicate a procedure of the kind initially specified and an appropriate device which exhibit a relatively small energy consumption.

This task is solved by the fact that the heat distribution medium stream before its introduction is

cold-consolidated into the lower range of the mixing column. By "cold compression" a compression procedure is understood here, into the medium which can be consolidated (here: the heat distribution medium stream) at a temperature occurs, which lies clearly below the freezing point of water, in particular below 230 K. With the invention the Wärmeträgerstrorn preferably occurs at a temperature from 95 to 150 K the cold compression.

Thereby the increase in pressure in the heat distribution medium stream, which is necessary for an enterprise of the mixing column under higher than pressure column pressure, can be made in energetically particularly favorable way.

The use of a cold compressor with the production of an oxygen-rich pressure product is actually well-known. Thus for example in EP 624767 A1 or in CSU 748098 is suggested bringing gaseous oxygen product of a rectification system by cold compression to its product pressure. In contrast to this with the invention the gaseous product is not cold-consolidated, but a heat distribution medium stream, which is led into a mixing column, from which the pressure product is taken off. Surprisingly with the fact it turned out that the use of a cold compressor has here a larger effect than the direct cold compression of the product. In the case of the same product pressure thereby an energy advantage results also in relation to other processes with cold compression.

Preferably employment air is consolidated to a first pressure, which is higher than the operating pressure of the Drucksäule. A first component current of employment air consolidated to the first pressure is inserted into the Drucksäule. A second component current of employment air consolidated to the first pressure forms the heat distribution medium stream and for the cold compression is supplied. Thereby it is favorable if both air component currents are cooled down together in a main heat exchanger against current reversals. After withdrawal from the cold end of the main heat exchanger the second component current is then branched off and led directly to the cold compression.

The first pressure lies preferably slightly above the operating pressure of the Drucksäule, so that harvest component current without further pressure-changing measure into the Drucksäule be inserted can. The difference between first pressure and pressure column pressure is selected in such a way in this case that the first component current can overcome straight flow resistances in the apparatuses lying between compression and Drucksäule such as cleaning mechanism, heat exchanger and/or lines. Preferably total air is consolidated together in an air compressor to the first pressure and subjected afterwards to a cleaning.

Downstream the heat distribution medium stream is preferably brought to the cold compression in indirect heat exchange with the oxygen-rich parliamentary group upstream the introduction into the mixing column. Thus the compression heat developed during the cold compression is removed and the heat distribution medium stream on for instance the operating temperature of the mixing column is cooled down. This leads to a particularly favorable mode of operation of

the mixing column.

It is energetically particularly favorable, if a process stream is work-carrying eased out and at least one part of the energy produced during the work-carrying out relaxation of the process stream for the drive of the cold compression is used. Preferably the cold compressor is mechanically coupled with the relaxation machine, in which the work-carrying out relaxation of the process stream is accomplished. It is machine simplest, if the relaxation machine is braked exclusively by the cold compressor.

The process stream is formed for example by a further (third) component current of the employment air, which after the work-carrying out relaxation into the low pressure column one introduces. Here a coupling with the cold compressor is particularly favorable. A pressure at the entrance into the work-carrying out relaxation can be higher for example for instance equal to the operating pressure of the Drucksäule or. During the interpretation of this procedure variant an optimization of the mass flow of air eased into the low pressure column and the purity of the oxygen product as a function of the desired pressure and the desired purity in the final product, which can be reached in this column, is to be made.

Additionally or alternatively another (here than "fourth" more designation) component current of employment air can be after-consolidated, eased work-carrying out and introduced into the Drucksäule. In principle it is also here possible to transfer mechanical energy to the cold compressor. Preferably the relaxation machine for the fourth partial air flow is however coupled with a warm Nachverdichter, in which the fourth component current is compressed upstream its work-carrying out relaxation. For reconciliation by cooling losses and for the product liquefaction necessary cold weather can be produced by the work-carrying out relaxation of the fourth partial air flow if necessary.

In addition the invention concerns a device for the production of a pressure product by very low-temperature dismantling of air in accordance with patent claim 8.

The invention as well as further details of the invention are more near described in the following on the basis remark examples represented schematically in the designs. Here show

Fig. 1 a first remark example of the invention and

Fig. 2 and 3 variants of this remark example.

In Fig. 1 is represented a two-column process with Drucksäule 5 and low pressure column 14. They become in the concrete example under an operating pressure of approx. 5,0 bar and/or 11,3 bar (in each case at the head) operated. Here also smaller quantities of liquid oxygen and/or liquid nitrogen can be produced beside the gaseous pressure product. Over line 1 cleaned air under a pressure of 5,1 bar advanced (air compressors and air cleaning are not represented) and

in the remark example into altogether four component currents is divided.

A first air component current flows in over line 2 into a main heat exchanger 3, against current reversals on for instance dew point temperature is cooled down there and finally over line 4 directly into the lower range of a Drucksäule 5 fed. A second component current of employment air is led together with first by the main heat exchanger 3, branched off across line 6 and after-consolidated in a cold compressor 7 to approximately 9.1 bar. Cold-consolidated air 8 is cooled down in a heat exchanger 9 and finally supplied by way of line 10 to a mixing column 50, directly above the sump. The operating pressure of the mixing column 50 here amounts to about 9.0 bar.

A third component current of air is inserted likewise together with first and the second component current into the main heat exchanger 3, but cooled down only up to a first intermediate temperature. Under this intermediate temperature it flows over line 11 to a first turbine 12 and work-carrying out on approximately 1.4 bar is eased there. The relaxed third component current 13 of air is fed directly into the low pressure column 14.

Already in the warm one a fourth component current 15 of employment air is branched off. It is after-consolidated in two Nachverdichtern 16, 18 to approximately 26 bar and after-cooled behind each stage (17, 19). The highly compressed fourth component current 20 is cooled down in the main heat exchanger on a second intermediate temperature, which is equal, higher or lower than the inlet temperature of the first turbine 12. Under this second intermediate temperature it is transmitted to a second turbine 22 over line 21, eased there work-carrying out on approximately 5.1 bar and finally supplied by way of the lines 23 and 4 of the Drucksäule 5. While the first Nachverdichter 16 is propelled by means of external energy, the second Nachverdichter 18 is mechanically coupled with the second turbine 22 over a common wave or a transmission.

Raw oxygen 24 out sump of the Drucksäule 5 is in-throttled - if necessary after undercooling in the Unterkühlungsgegenströmer 25 - into the low pressure column 14 (26). Head ticking off 27 of the Drucksäule 5 is condensed at least to a first part of 28 in a main condenser 29 against evaporating sump liquid of the low pressure column 14. At least one part of 31 of the condensate 30 formed thereby is given up as return on the Drucksäule. Over line 32 if necessary a liquid nitrogen product can be taken off. From an intermediate place, which is appropriate for about 5 to 20 theoretical and/or practical soils underneath the head, over line 33 a nitrogen-rich liquid is taken off, given up after flowing through the Unterkühlungsgegenströmers 25 eased (34) and as return on the low pressure column 14.

A second part of 35 of the head ticking material 27 of the Drucksäule 5 is warmed up in the main heat exchanger 3 on approximately ambient temperature and delivered as gaseous pressure ticking off product 36.

Leave the low pressure column 14 two rivers, i.e. nitrogen-rich remainder gas 51 at the head and oxygen-rich liquid 37 at the sump. The remainder gas 51 flows to the Unterkühlungsgegenströmer of 25 and far over line 38 to the main heat exchanger 3. It leaves the main heat exchanger 3 under approximately ambient temperature over line 39 and can as dry by-product and/or as regeneration gas for the adsorbent of the not represented air cleaning be used and/or into the atmosphere blown off.

The oxygen-rich liquid 37 of the sump of the low pressure column 14 points a purity in the remark example from approx. 98 mol% up. It can be partly won over line 40 than liquid oxygen product. Otherwise it is brought to 41 or another well-known means by means of a pump in liquid condition on a pressure by approximately 10 bar, promoted by means of line 42 and - after warming up in the heat exchanger 9 - far by means of line 43 to the mixing column 50. The feed point preferably is because of the head of the mixing column 50. A gaseous head product 44 is inferred from the mixing column 50. After warming up in the main heat exchanger 3 this binds a gaseous oxygen pressure product 45.

From an intermediate place of the mixing column 50 and from their sump two liquid stream 46, 47 are taken off and transmitted after undercooling in the heat exchanger 9 to the low pressure column 14 (line 48 and/or 49). The undercooling in 9 serves the reduction of the Flashgasmenge with a throttles into the low pressure column 14.

In Fig. 2 represented process differed from that from Fig. 1 by a higher entrance pressure at the first turbine 12. This is caused by the fact that the third component current of air before its introduction 251 into the main heat exchanger 203 in a Nachverdichter 216 is compressed on a pressure by for example 10 bar. Thus the drive power for the cold compressor can be increased. By means of an accordingly larger mixing column pressure a higher product pressure is reached by for example 11 bar in the oxygen pressure product. Turned around the quantity of air injected into the low pressure column can be reduced with continuous mixing column pressure and thus the separation process in this column be improved.

If also a fourth air flow 252 exists, which is eased over a second turbine 22 into the Drucksäule, a partial common Nachverdichtung 216 and re-cooling 217 third and the fourth component current is favorable. In the example the third component current 251 and the fourth component current 252 behind the final cooler 217 branch out. First and the second air component current are led together in the example independently of the third component current by the main heat exchanger 3 (202).

Also Fig. to 3 to a large extent Fig corresponds. 1, however is coupled in the procedure the second turbine 322 to a generator 353 outlined here. This is to be preferred machine more favorable and therefore in certain applications.

In the remark examples the exchange of material elements in the low pressure column by

arranged packings and in the Drucksäule as well as in the mixing column are formed by sieve inserts. In principle however conventional exchange of material soils (for example Siebbböden) know, filling material (unordered packing) during the procedure and the device of the invention and with the remark example and/or arranged packing in each of the columns to be used. Also combinations of different elements in a column are possible. Preferably the exchange of material elements in pressure and mixing column by soils and in the low pressure column are at least partly formed at least partly by arranged packing.

1. Procedure for the production of a pressure product (45) by very low-temperature dismantling of air in a rectification system, which exhibits a Drucksäule (5) and a low pressure column (14), with that

a) consolidated and cleaned employment air (1, 4) is inserted into the Drucksäule (5),
b) at least one parliamentary group (24) from the Drucksäule (5) eases (26) and into the low pressure column (14) one feeds,
c) an oxygen-rich parliamentary group (37, 42) from the low pressure column (14) liquid on pressure brought (41) and on a mixing column (50) given up (43) becomes,
d) a heat distribution medium stream (1, 2, 6, 8, 10) is introduced into the lower range of the mixing column (50) and brought counter current against the current with the oxygen-rich parliamentary group (43) and
e) out of the upper range a gaseous head product (44) one takes from the mixing column (50) and one wins as pressure product (45),
by the fact characterized that

a) the heat distribution medium stream (6) before its introduction (8, 9) into the mixing column (50) (7) becomes cold-consolidated.

2. Procedure according to requirement 1, by the fact characterized that employment air is consolidated to a first pressure, which is higher than the operating pressure of the Drucksäule that a first component current (2, 202, 4) of employment air (1), consolidated to the first pressure, is inserted into the Drucksäule (5) and that a second component current (2, 202, 6) forms for employment air (1), consolidated to the first pressure, the heat distribution medium stream (6, 8, 9) and to the cold compression (7) is supplied.

3. Procedure according to requirement 1 or 2, by the fact characterized that the heat distribution medium stream (8) is brought downstream to the cold compression (7) in indirect heat exchange (9) with the oxygen-rich parliamentary group (42) upstream the introduction (43) into the mixing column (50).

4. Procedure after one of the requirements 1 to 3, by the fact characterized that a process stream (11) is used work-carrying out relaxed (12) will and at least one part during the work-carrying out relaxation (12) of the process stream produced energy for the drive of the cold compression (7).

5. Procedure after one of the requirements 1 to 4, by the fact characterized that (third) a component current (11) of employment air eases work-carrying out (12) and into the low pressure column (14) (13) becomes introduced.

6. Procedure according to requirement 5, by the fact characterized that at least one part during the work-carrying out relaxation (12) (third) of the component current (11) for employment air it

produced energy for the drive of the cold compression (7) is used.

7. Procedure after one of the requirements 1 to 6, by the fact characterized that (fourth) a component current (15, 252, 20, 21) of employment air after-consolidates (16, 216, 18), work-carrying out relaxed (22, 322) and into the Drucksäule (5) (23, 4) becomes introduced.

8. Device for the production of a pressure product (45) by very low-temperature dismantling of air with a rectification system, which exhibits a Drucksäule (5) and a low pressure column (14), and also

a) an employment air line (1, 4) to the introduction of consolidated and cleaned employment air into the Drucksäule (5),
b) Means (24, 26) to the feed at least one parliamentary group from the Drucksäule (5) into the low pressure column (14),
c) Means (41, 42, 43), in order to bring and on a mixing column (50) give an oxygen-rich parliamentary group up (37) from the low pressure column (14) liquid on pressure,
d) Means (1, 2, 202, 6, 7, 8, 10) to the introduction of a heat distribution medium into the lower range of the mixing column (50) and also
e) a head product line (44, 45) to the withdrawal of a gaseous head product of the upper range of the mixing column (50) as pressure product,
through characterized that

a) the means for the introduction of a heat distribution medium into the lower range of the mixing column (50) a cold compressor (7) exhibit.